University of Bahrain
College of Information technology
Department of Computer Engineering

Test (1)

Student Name
I.D. No.
Section

Course Title: Digital Logic
Course number: ITCE 202-ITCE 250
Semester: 1
Academic Year: 2015/2016
Duration : 1 hour
Date: 28th October 2015

Read the following before you start:
1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only.

Question	Mark	Mark attained
1	25	25
2	25	25
3	25	25
4	25	25
Total	100	100

Question [1]: [25 mark]

(a) What is the range of signed binary numbers to be represented in 2's complement using 6-bit word length?

$$\text{range} = [-2^5, +2^5 - 1] = [-32, +31]$$ [3 marks]

(b) Perform the following operation for in 2's complement using 6-bit word. [5 marks]

$(-12)_{10}-(15)_{10}=$

$-12 \Rightarrow 1\,10100$

$+\ -15 \Rightarrow +\ 1\,10001$

$\overline{1\,00101}$

↳ Correct answer, no overflow

	16	8	4	2	1	0	
12→	0	1	1	0	0		10000
15→	0	1	1	1	1		10001
		1	0	0	1	1	
		+				1	
		1	0	1	0	0	

(c) Convert the following numbers showing all steps. [3 marks each, 12 marks]

$(1B5.2)_{16} = (\ 665.1\ )_8$

$(1\,B\,5.2)_{16} = (0001\ 1011\ 0101.0010)_2$

$(75)_{10} = (1000\ 0110)_{7\text{-}3\text{-}2\text{-}1}$

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$(56)_{10} = (1000\ 1001)_{\text{excess-3}}$

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$(11011100)_{\text{2's complement}} = (\ 10100011\ )_{\text{1's complement}}$

$1\,0111100$

$-\quad 101$

$\overline{1\,0110\,11}$

(e) Convert and add the following numbers in Binary Coded Decimal BCD. [5 marks]

$(85)_{10}+(36)_{10}=$

$(85)_{10} \Rightarrow 1000\ 0101$

$+\ (36)_{10} \quad +\ 0011\ 0110$

$1011\ 1011$ → does not exist in BCD, add 6

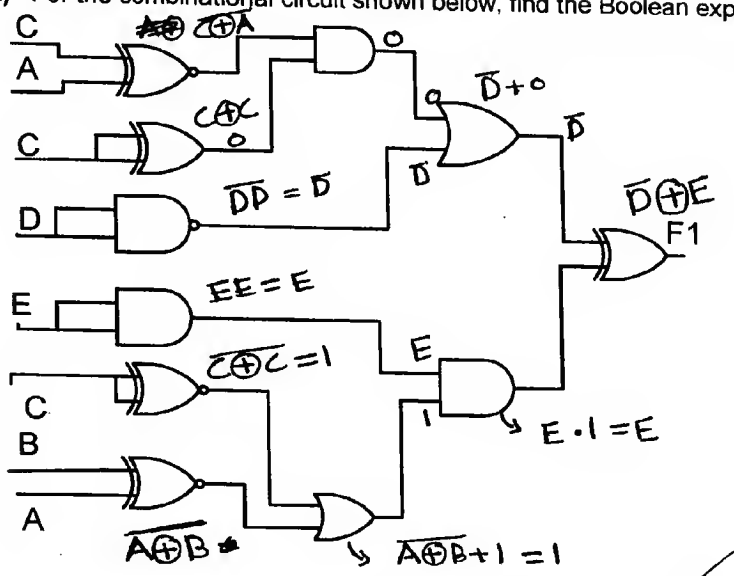
$+\ 0110\ 0110$

$0001\ 0010\ 0001$

1 2 1

Question [2] : [25 mark]

(a) For the combinational circuit shown below, find the Boolean expression for the output F1.



$F_1 = \overline{D} \oplus E$

a- Use Boolean algebra to Simplify the following:

$a\overline{b}c + adc + \underline{b}dc + \overline{b}c$ (consensus term)

$= a\overline{b}c + adc + \underline{b}dc + \overline{b}c$

$= a\overline{b}c + bdc + \overline{b}c$

$= \overline{b}c(a+1) + bdc$

$= \overline{b}c(1) + bdc = \overline{b}c + bdc$

$= c(\overline{b} + bd) = c((\overline{b}+b)(\overline{b}+d)) = c(1)(\overline{b}+d)$

$= c\overline{b} + cd$

$dc(ac) = adc$

Question [3]: [25 mark]

We want to construct the truth table of a "disk spinning" animation circuit for a CD player. The input to the circuit will be a 3-bit binary number $A_1A_2A_3$. The animation will appear on the top four segment of the 7-segment display shown in Figure (1), i.e. on segment **a**, **g**, **e**, **f**. The pattern is shown in Figure (2).

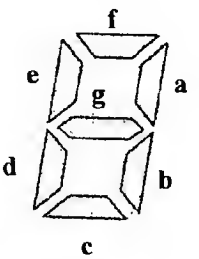


Figure (1) 7-segment display

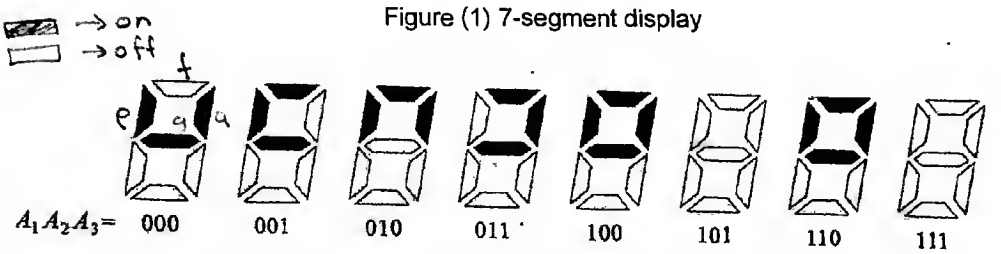


Figure (2) Pattern of the required animation.

(a) Construct a truth table of the circuit.
(b) Write the minterm expansion of segment **a** both in decimal form and algebraic form.
(c) Write the maxterm expansion of segment **g** in decimal form.
(d) Write the maxterm expansion of segment $\bar{e}$ in decimal form.

segments b, d, c are not considered

m	A_1	A_2	A_3	a	g	e	f	$\bar{e}$
0	0	0	0	1	1	1	0	0
1	0	0	1	0	1	1	1	0
2	0	1	0	1	0	1	1	0
3	0	1	1	1	1	0	1	1
4	1	0	0	1	1	1	1	0
5	1	0	1	0	0	0	0	1
6	1	1	0	1	1	1	1	0
7	1	1	1	0	0	0	0	1

b) $a = \bar{A}_1\bar{A}_2\bar{A}_3 + \bar{A}_1A_2\bar{A}_3 + \bar{A}_1A_2A_3 + A_1\bar{A}_2\bar{A}_3 + A_1A_2\bar{A}_3$

$a = \sum m(0,2,3,4,6)$

c) $g = \prod M(2,5,7)$

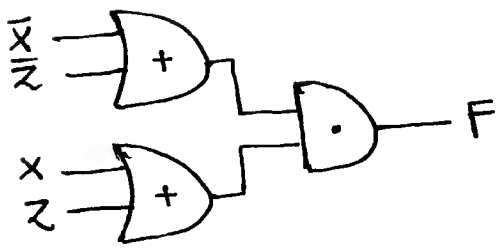
d) $\bar{e} = \prod M(0,1,2,4,6)$

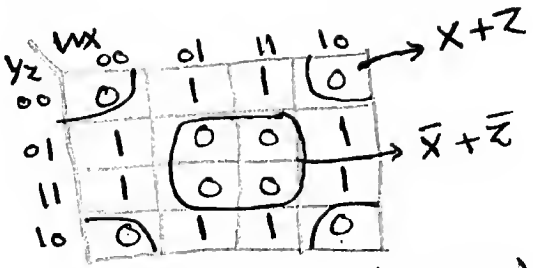
Question [4]: [25 mark]

a- Implement the following Boolean function with minimum number of gates using OR-AND implementation.

OR-AND
PoS

$$F(W, X, Y, Z) = \Sigma m(1,3,4,6,9,11,12,14)$$





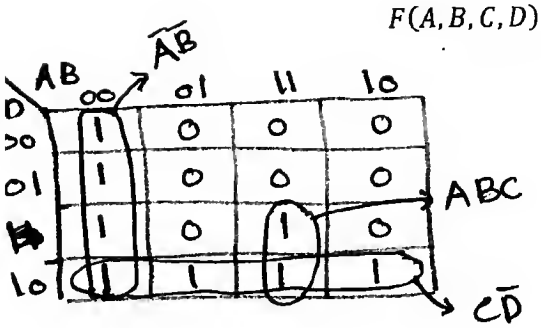
$$F = (\bar{X} + \bar{Z})(X + Z)$$

b- Use K-map to simplify the following function then to implement it with a minimum number of gates using AND-OR implementation.

AND-OR
SoP

$$F(A,B,C,D) = \bar{A}\,\bar{B} + C\bar{D} + ABC + \bar{A}\bar{B}\,C\bar{D} + ABC\bar{D}$$

$$ABC \rightarrow 111X \rightarrow 1110, 1111 \quad (14, 15)$$



$$F = \bar{A}\bar{B} + C\bar{D} + ABC$$